Structure and Mechanical Properties of Nickel Electrodeposits

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ABSTRACT

Relationship of “ processing/microstructure/mechanical-properties ” of electrodeposited nickel was established to achieve better understanding of the annealing behaviors Ni deposits. 70?m-thick Ni was electrodeposited onto copper plates from Ni sulfamate baths with the addition of various amounts of chloride and ammonium ions. Electroplating parameters studied include solution temperature, current density and pH. Ni deposits were then annealed at temperatures ranging from 200 to 600 °C?for 1hr. Optical microscopy, scanning electron microscopy, transmission electron microscopy, and x-ray diffraction technique were used to characterize the microstructure and texture of Ni deposits, particularly the grain structure and lattice defects. Fibrous structure of [110] texture was observed for Ni deposits plated from 40 °C bath at current density less than 1 A/dm2. Recrystallization and grain growth occur after annealing at temperatures higher than 400 °C. Ni deposits plated at current density above 1 A/dm2 show well-defined columnar grain structure with strong [100] texture. [100] oriented Ni deposits are softer and still exhibit columnar grain structure even after 600 °C annealing. Although Ni deposits plated at various current densities exhibit a bimodal grain structure, average grain size of Ni deposits increases with current density. In contrast, lattice defects of Ni deposits decreases with current density. For 40 °C baths, pH variations between 3.0 and 5.0 show little effect on the texture and structure of Ni deposits, which consist of columnar grains with [100] texture. Columnar grain structure still exists up to 600 °C annealing. Addition of ammonium and chloride ions modifies the electrocrystallization and growth of Ni deposits. For 40 °C bath, texture of Ni deposits change from strong [100] to weak [100], and then to weak [110] with the increase of ammonium ions in the bath. With the addition of 100 ppm ammonium ions into 50 °C bath, Ni deposits exhibit a mixture of [110] and [310] textures. Ni deposits with [110] and/or [310] textures suffer recrystallization after 400 °C annealing. Addition of 30g/l NiCl2.6H2O into 40 °C bath results in the texture change from [100] to weak [100]. [110] oriented Ni deposits are plated from 50 °C bath with the addition of 3 ~ 60g/l NiCl2.6H2O. Recrystallization of Ni deposits with weak [100] orientation and with [110] orientation occur after 400 °C annealing. In general, Ni deposits with inhibition textures, such as [110] and [310], tend to recrystallize after 400 °C annealing. In contrast, strongly [100] oriented Ni deposits still exhibit columnar grain structure even after 600 °C annealing.

Keywords : 胺基磺酸鎳浴 ; 穿透式電子顯微鏡 ; 纖維晶 ; 再結晶與晶粒成長 ; 柱狀晶 ; 優選方位

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